CHAPTER 2: PORTFOLIO EVOLUTION

MISO manages the life cycle of an extensive and diverse fleet of resources that continues to experience a shift from conventional fossil fuel generation to renewable technologies. With the shift away from dispatchable generation close to load centers to remote variable energy resources, the transmission system no longer serves the same resources for which it was designed, and transmission upgrades are needed to enable integration of new generation facilities.

2.1 Historical Trends and Retirements

MISO manages the retirement of generation facilities through the Attachment Y process to ensure that reliability is maintained when resources are removed from service. Generators submit Attachment Y requests for MISO approval once the impact of the retirement is assessed and any reliability issues are addressed through transmission reinforcements or other needed mitigation measures. If the reliability issue cannot be addressed, MISO may require the unit to remain in service as a system support resource until the upgrade is complete, or mitigation is available. In recent years the need for system support resources has diminished and no generation resources are currently operating under an SSR agreement.

Resource retirements of coal and gas-fired generation have seen a steady increase in the past several years as renewables have become economically and environmentally more attractive sources of energy. In the last 10 years MISO has experienced retirement of 24.9 GW of which 17.5 GW was coal based (Figure 2.1-1). The age of generating facilities retired in 2020 to date has declined to 46 years compared to 57 years in 2010 displaced largely by the interconnection of more economic renewable resources. Advancements in technology and interest in renewables are expected to continue the current trend.

![Generation Retirement Trend by Fuel Type](image)

Figure 2.1-1: MW generation retirement by fuel type
2.2 Current State of Queue

The MISO generation interconnection queue provides an active and competitive mechanism to enable resource interconnections that will serve future energy and capacity needs. Projects submitted in the annual queue cycle are evaluated by MISO through an iterative study process to determine the reliability impacts and to identify transmission upgrades needed to support resource integration. Project viability is often tied to the costs of network upgrades with the most viable candidates successfully executing a Generation Interconnection Agreement.

The GI queue has experienced high volume over the last several years as a result of growing interest in renewable technology that has benefitted by declining costs of technology, favorable tax incentives and regulatory treatment. Wind has comprised a large portion of the interconnection queue volume in the last decade while solar resources have emerged more recently in part due to advances in solar technology and escalating transmission costs associated with wind development. As battery storage technology advances and interest continues to grow, MISO has seen an increase in number of the projects comprised of standalone storage or hybrid applications.

In 2020, MISO received 353 individual project requests representing a total of 52.5 GW of requested capacity during the application period that ended in June (Figure 2.2-1) marking a continuing trend of aggressive resource development. Solar installations have continued to trend upward, representing 69% of new entries and new wind development has shown a reversal of a downward trend from the prior year. With the additional requests received in the latest queue cycle, the total volume of active queued projects has reached 91.6 GW as of July.

![Figure 2.2-1 GI Queue by Fuel Type over the last ten years](image)
2.3 Fleet transition costs are changing and impactful

In the past, the MISO Multi Value Project (MVP) Portfolio facilitated new renewable resource development that delivered regional benefits by enabling access to lower cost energy. This broad regional approach to transmission planning recognized the benefits of a regional plan that would result in the most cost-effective transmission investment rather than an incremental build-out resulting from the generation interconnection process. Over the last decade, the continued interconnection of new resources has fully utilized the additional capacity provided by the MVPs resulting in the need for more network upgrades to support ongoing interconnection requests. The continued growth of remotely located renewable resources has resulted in the need for major transmission upgrades with a significant increase in transmission costs incurred for resource interconnections. As the industry transitions away from traditional central station generation to more dispersed and variable energy resources, transmission investment will be needed to facilitate the change and support continued reliability. A comprehensive approach to system planning and resource interconnection recognizes broader benefits of transmission investment while facilitating resource evolution in a timely manner.
2.4 Planning for the Future

Due to the long lead time of constructing new transmission infrastructure (identification of project, design, regulatory approval, construction, and energization), effective transmission planning must occur nearly 10 years prior to a significant transmission need, in most cases. To address this, MISO has developed a process to prudently plan transmission over a 10- to 20-year period that captures a wide array of potential resource fleet changes and conditions due to political, economic, technological, industrial, commercial, and consumer trends. This process utilizes multiple planning scenarios, or “Futures” to bookend the spectrum of potential changes before they happen.

The MTEP20 cycle included four Futures: Limited Fleet Change (LFC); Continued Fleet Change (CFC); Accelerated Fleet Change (AFC); and Distributed and Emerging Technologies (DET). These four Futures include only slight modifications from those developed in MTEP 2019 which incorporated substantial modifications with extensive stakeholder collaboration to retool the Futures to better reflect the rapid resource portfolio changes the region is experiencing. The minimal updates to the Futures for MTEP20 include updates reflecting interconnection queue activity, retirements, additions, as well as an updated unit/resource dataset from ASEA Brown Boveri (ABB), the Swiss-Swedish multinational corporation that maintains the PROMOD simulation tool and data.

The four MTEP20 Futures are:
- Limited Fleet Change (LFC)
- Continued Fleet Change (CFC)
- Accelerated Fleet Change (AFC)
- Distributed and Emerging Technologies (DET)

The goal of MTEP Futures is to bookend uncertainty by defining a wide range of potential plausible outcomes.

The Regional Resource Forecasting (RRF) process uses the assumptions defined within each Future to economically identify the least-cost portfolio of new supply-side and demand-side resources. Base data assumptions in the associated ABB PowerBase database are presented in Appendix E along with fuel forecasts, new unit construction costs, emissions constraints, retirement assumptions, renewable energy assumptions and regional demand and energy projections. The resulting resource additions and retirements from the MTEP19 regional resource forecasting process are shown in Figure 2.4-1.
To produce the future capacity mix in 2033 for each Future, the retirements and new resources identified from the regional resource forecasting process must be applied to the existing generation fleet (Figure 2.4-3).
Figure 2.4-2: MISO 2033 Futures capacity mix by resource

Figure 2.4-3: MISO 2033 Futures energy utilization mix
The results from the regional resource forecasting process identify the type, size and installation date of new resources. However, they do not specify where these units should be located within the MISO footprint. Therefore, new resources identified in the regional resource forecasting process must be sited within the economic production cost model. The Futures siting process is based on stakeholder-agreed-upon rules and criteria detailed in section 4 of Appendix E (Figure 2.4-4).

Additional details regarding Futures development, resource forecasting, and siting processes are in Appendix E of this report.
Looking ahead as it began the MTEP20 cycle, MISO saw increasing momentum in fleet development and many stakeholders noted how new generation could outpace bookends within the planning horizon. With the accelerated pace of fleet change in mind, MISO engaged stakeholders to better align the new Futures cohort for MTEP21 to stay ahead of real-world developments and encompass or bookend the spectrum of potential changes before they happen.
2.5 Current generation fleet must continue to be deliverable to load

MISO performs generator deliverability analysis as a part of the annual MTEP process to ensure continued deliverability of generating units with firm service, including Network Resource Interconnection Service. The generation deliverability analysis results in the identification of projects which mitigate transmission system constraints that restrict generation output below the established network resource amount. Results of the assessment are determined on an analysis of near-term (five-year) summer peak scenario.

Observed constraints that restrict generation beyond the established Network Resource amounts require mitigation.

### MTEP20 Constraints

In MTEP20, constraints present are due to major construction efforts in the area and two MTEP19 projects were identified to mitigate these constraints which restrict generation beyond the established network resource amount (Table 2.5-1). These projects, along with alternatives, were reviewed by stakeholders in the MTEP19 planning process and were approved for construction.

<table>
<thead>
<tr>
<th>Overloaded Branch</th>
<th>Area</th>
<th>Mitigation MTEP19 ID</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>John Junction – Morris</td>
<td>OTP</td>
<td>17006</td>
<td>Mitigated scheduled by Appendix A in MTEP19. MISO identified thermal overloads on the John Junction to Morris 115 kV circuit 1 and Ortonville to John Junction 115 kV circuit 1 during the MTEP19 Deliverability Analysis</td>
</tr>
<tr>
<td>115 kV circuit 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ortonville – John Junction 115kV circuit 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Big Stone – Browns Valley 230 kV circuit 1</td>
<td>OTP</td>
<td>16965</td>
<td>Mitigated scheduled by Appendix A in MTEP19. MISO identified thermal overloads on the Big Stone to Browns Valley 230 kV circuit 1 during the MTEP19 Deliverability Analysis</td>
</tr>
<tr>
<td>Crossroads – Clarksdale 115kV circuit 1</td>
<td>EMBA/CLECO</td>
<td>NA</td>
<td>Mitigated by Crossroads SPS which will trip one of the Crossroads units to provide relief</td>
</tr>
</tbody>
</table>

Table 2.5-1: Projects identified to alleviate MTEP20 constraints that limit deliverability of network resources